

Scientific Inquiry

3-1 The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

3.1.1 Classify objects by two of their properties (attributes).

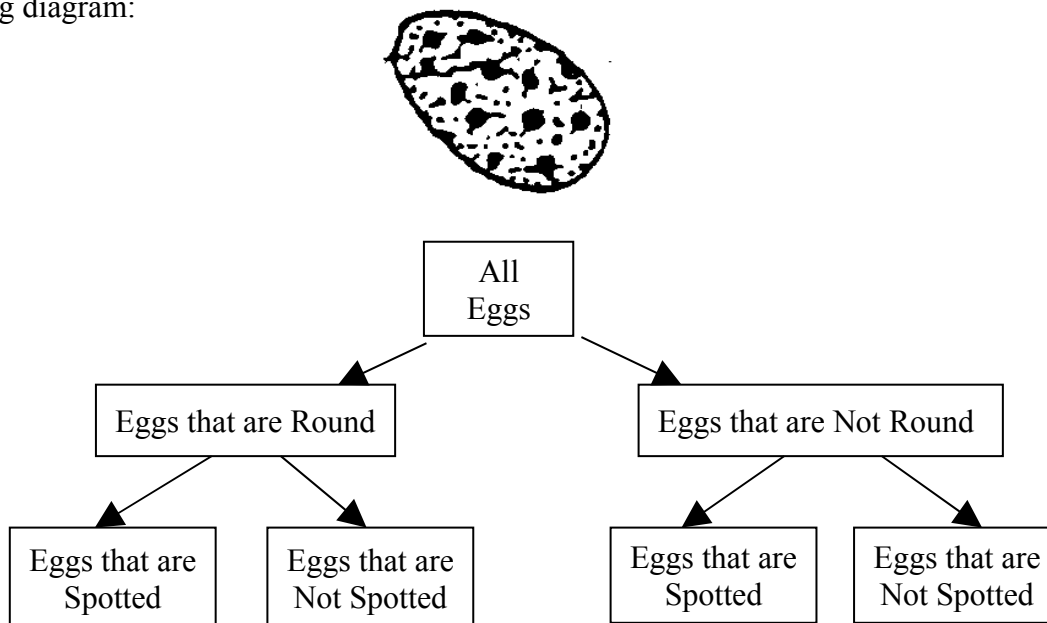
Taxonomy Level: 2.3-B Understand Conceptual Knowledge

Previous/Future knowledge: In kindergarten, students compared objects by using nonstandard units of measurement (K-1.4), and classified objects by observable properties (including size, color, shape, magnetic attraction, heaviness, texture, and the ability to float in water) (K-5.1). In 1st grade (1-1.1), students compared, classified, and sequenced objects by number, shape, texture, size, color, and motion, using standard English units of measurement where appropriate. In 6th grade (6-1.3), students will classify organisms, objects, and materials according to their physical characteristics by using a dichotomous key.

It is essential for students to classify objects by two *properties*, or attributes, so that similarities and differences can be observed between objects. To classify by two properties,

- First, observe the objects.
- Find out what properties they have that are the same and what they have that are different.
- Choose one property.
- Classify all objects into two groups based on one property—the objects either have the property (group 1) or they do not (group 2).
- Next, take all the objects in group 1 and classify them into two smaller groups based on a second property.
- Then, take all the objects in group 2 and classify them into two smaller groups based on a second property.
- The second property used to further classify the groups does not have to be the same for each of the groups.

For example, to determine the group to which the egg belongs based on its properties, use the following diagram:



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It is not essential for students to classify observations as either quantitative or qualitative. Students do not need to know how to create or use a dichotomous key to identify an unknown object.

Assessment Guidelines:

The objective of this indicator is to *classify* objects by two of their properties; therefore, the primary focus of assessment should be to categorize objects by two attributes. However, appropriate assessments should also require students to *identify* the properties by which an object was grouped; *compare* groups to determine similarities and differences; or *explain* why an object was placed into a particular group.

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3.1.2 Classify objects or events in sequential order.

Taxonomy Level: 2.3-B Understand Conceptual Knowledge

Previous/Future knowledge: In kindergarten (K-1.4), students compared objects by using nonstandard units of measurement. In 1st grade (1-1.1), students compared, classified, and sequenced objects by number, shape, texture, size, color, and motion, using standard English units of measurement where appropriate. In 6th grade (6-1.3), students will classify organisms, objects, and materials according to their physical characteristics by using a dichotomous key.

It is essential for students to group objects or events in sequential order.

- Objects or events can be placed in order according to a particular property, such as size, shape, color, or some other characteristic.
- Another way to place objects or events in order is based on what occurred first, second and so forth.

It is not essential for students to classify observations as either quantitative or qualitative.

Assessment Guidelines:

The objective of this indicator is to *classify* objects or events in sequential order; therefore, the primary focus of assessment should be to arrange objects in increasing or decreasing order. However, appropriate assessments should also require students to *identify* the property by which the objects were sequenced; or *explain* why objects were sequenced in a particular order.

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3-1.3 Generate questions such as “what if?” or “how?” about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation.

Taxonomy Level: 6.1-B and 3.2-B Create and Apply Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-1.3), students carried out simple scientific investigations when given clear directions. In 2nd grade (2-1.1), students carried out simple scientific investigations to answer questions about familiar objects and events. Students will make a prediction and compare results in 3-1.4. In 5th grade (5-1.1), students will identify questions suitable for generating a hypothesis. In 7th grade (7-1.2), students will generate questions that can be answered through scientific investigations. In 8th grade (8-1.4), students will generate questions for further study on the basis of prior investigations.

It is essential for students to create their own questions through exploration, observations, or just curiosity about objects, organisms, and events in the environment. These questions can ask things such as “what”, “when”, “where”, “why” or “how”. Not all of these questions lead to scientific investigations, but they may be used to gain information that would then lead to a testable question. *A testable question* is one in which an experiment is needed to find the answer.

Testable questions will then be used to conduct a simple scientific investigation such as:

- *What if* an object is pushed with different strengths?
- *What if* plants were watered with salt water?
- *What* affects the time it takes ice to melt?
- *How* does changing the length of an instrument string affect its pitch?
- *How* does camouflage help an animal survive in its habitat?

NOTE TO TEACHER: Not all questions are scientific questions that can lead to a scientific investigation. Questions such as “What is a plant?” or “How far away is the Sun?” do not lend themselves to the steps involved in conducting simple scientific investigations. The type of investigation will vary depending on the question being asked.

Steps for conducting a simple scientific investigation may be:

- Ask the question to be investigated
- Make a prediction (possible answer to the question)
- Decide what materials are needed for the experiment
- List steps to carry out the experiment that will test (change) only one factor or relationship; all other factors must be kept the same.
- Record observations and organize the data as the experiment is carried out
- Communicate the results or infer meaning from the data

NOTE TO TEACHER: Students can record data in prepared charts, tables, and graphs in order to make it easier to explain the results.

It is not essential for students to identify variables as manipulated or responding variables, but the term “variable” might be introduced as a factor that is changed in the investigation.

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Assessment Guidelines:

The objective of this indicator is to *generate* questions such as “what if?” or “how?” about objects, organisms, and events in the environment; therefore, the primary focus of assessment should be to create or devise appropriate questions for a simple scientific investigation. However, appropriate assessments should also require students to *identify* an appropriate question that could be investigated.

Another objective of this indicator is to *use* generated questions to conduct a simple scientific investigation; therefore, the primary focus of assessment should be to apply carry out investigation procedures that answer the question. However, appropriate assessments should also require students to *predict* the outcome of an investigation; *identify* appropriate tools for an investigation; *identify* appropriate steps needed to answer a question; *identify* observations related to an investigation; or *infer* (or draw conclusions) from the results of an investigation.

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3-1.4 Predict the outcome of a simple investigation and compare the results with the prediction.

Taxonomy Level: 2.5-B and 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In kindergarten (K-1.3), students predicted and explained information or events based on observations or previous experience. In 2nd grade (2-1.4), students inferred explanations regarding scientific observations and experiences. In 4th grade (4-1.4), students will distinguish among observations, predictions, and inferences. In 6th grade (6-1.2), students will differentiate between observation and inference during the analysis and interpretation of data.

It is essential for students to predict the outcome of a simple investigation and compare the result with the prediction.

- A *prediction* is an idea about what will happen in the future with an explanation of why. A prediction is not a guess.
- A prediction, which answers the question being investigated, should be given at the beginning of an investigation. It states the possible results of the investigation.
- After the investigation is completed, the results can be compared to the prediction to determine how close the prediction was to the results.

To make a *prediction*:

- Make observations and think about what is known about the object or event.
- Tell what will happen next.

NOTE TO TEACHER: Predictions should not be viewed as “right” or “wrong” but should be stated with a plausible explanation of why.

Scientific observations are made by using the senses or taking measurements. Making *observations* is a way of learning about the world around us.

- A *scientific observation* is one that anyone can make and the result will always be the same. For example, the animal is black, has four legs, and feels soft.
- An *unscientific observation*, or an opinion, is one that not everyone may agree on. For example, the dog is happy.
- Observing does not mean just looking at something. It involves the use of several or all of the five senses (seeing, hearing, smelling, touching, and tasting) using appropriate observation methods for each sense, such as wafting an odor so that its smell can be described or gently touching the edges of seashells to determine their textures.
- Tasting in science should only be done with the permission of the teacher under controlled conditions.
- Observing helps to find out about objects (their characteristics, properties, differences, similarities) and events (what comes first or last, or what is happening at a particular moment).

It is not essential for students to identify the variables in the investigation or that a hypothesis is a prediction that gives a relationship between the variables.

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Assessment Guidelines:

One objective of this indicator is to *predict* the outcome of a simple investigation; therefore, the primary focus of assessment should be to form an idea of an expected result based on observations or experiences. However, appropriate assessments should also require students to *infer* the outcome of a simple investigation; or *identify* observations used to formulate why a prediction is being made.

Another objective of this indicator is to *compare* the results of the investigation with the prediction; therefore, the primary focus of assessment should be to tell how the results were similar to or different from the prediction. However, appropriate assessments should also require students to *infer* from the results to make further predictions, or *interpret* data collected from the investigation.

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3-1 The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

3-1.5 Use tools (including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes) safely, accurately, and appropriately when gathering specific data.

Taxonomy Level: 3.2-B Apply Conceptual Knowledge

Previous/Future knowledge: In previous grades, students used magnifiers and eyedroppers (K-1.2), rulers (1-1.2), and thermometers, rain gauges, balances, and measuring cups (2-1.2) safely, accurately, and appropriately. In future grades, students will continue to use these tools, when appropriate, as well as use new tools when collecting scientific data. A complete list of tools can be found in Appendix A of the Academic Standards.

It is essential for students to know that every simple scientific investigation provides information. This information is called *data*. Data can be simple observations or measurements (in metric units or English units when appropriate).

It is essential for students to know that different tools are needed to collect different kinds of data.

- A *beaker* is a tool that measures liquid volume.
 - To read the volume of a liquid in a beaker, place the tool on a level surface.
 - When using a beaker to measure the volume of a granular (powdered) solid, be sure the top surface of the solid is level.
 - Choose the appropriate size beaker for the measurement task—use small beakers for measuring small amounts, and large beakers for large amounts.
 - A beaker measures the volume in metric units such as milliliters (mL) or liters (L).
- A *meter tape, or meter stick*, is a measurement tool that can be used to measure the length, width, or height of an object or the distance between two objects.
 - When using a meter tape, or stick, make sure to begin measuring from the zero (0) mark, not necessarily the edge of the tool.
 - A meter tape, or stick, measures in metric units such as centimeters (cm) or meters (m).
- *Forceps/tweezers* are tools that grasp or pick up small materials.
- A *tuning fork* is a tool that produces vibrations when struck appropriately.
 - Use the rubber mallet or rubber surface to strike the tuning fork.
- A *graduated cylinder* is a tool that measures volume of liquids.
 - To read the graduated cylinder, place the tool on a level surface.
 - Choose the right size graduated cylinder for the measurement task—use small graduated cylinder for measuring small amounts, and large graduated cylinder for large amounts.
 - The graduated marks are in metric units such as milliliters (mL).
- A *graduated syringe* is a tool that measures volume of liquids.
 - Place the end of the syringe in the liquid and then pull the plunger out to draw in the appropriate amount of liquid.
 - A graduated syringe measures in metric units such as milliliters (mL).

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It is essential for students to use care when handling these tools when gathering data.

- Some beakers and graduated cylinders are glass. Care should be taken not to break them.
- Forceps can be sharp. Care should be taken not to pinch or pierce someone.
- To avoid breaking or chipping, tuning forks should not be struck on the side of the desk.
- Care should be taken when heating glass beakers.

It is also essential for students to use tools from previous grade levels that are appropriate to the content of this grade level such as eyedroppers, magnifiers, rulers (measuring to millimeters), pan balances (measuring in grams), measuring cups (measuring in parts of a cup), or thermometers (measuring in °F and °C) to gather data.

NOTE TO TEACHER: See information in previous grades regarding how to use each tool. All temperature readings during investigations will be taken using the Celsius scale unless the data refers to weather when the Fahrenheit scale is used.

It is not essential for students to use triple beam balances. Tools from previous grades that are not appropriate to the content of this grade level are not essential; however, these terms may be used as distracters (incorrect answer options) for assessment, for example rain gauges. Students do not need to measure the volume of a solid using displacement. Students do not need to convert measurements from English to metric or metric to English.

Assessment Guidelines:

The objective of this indicator is to *use* tools safely, accurately, and appropriately when gathering data; therefore, the primary focus of assessment should be to apply correct procedures to the use of beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes and other tools essential to the grade level that would be needed to conduct a science investigation. However, appropriate assessments should also require students to *identify* appropriate uses for beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes; *illustrate* the appropriate tool for an investigation using pictures, diagrams, or words; *recall* how to accurately determine the measurement from the tool; *recognize* the correct metric units for each tool (such as mL for measuring volume with a graduated cylinder); or *recognize* ways to use science tools safely, accurately, and appropriately.

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3-1.6 Infer meaning from data communicated in graphs, tables, and diagrams.

Taxonomy Level: 2.5-B Understand Conceptual Knowledge

Previous/Future knowledge: In kindergarten (K-1.3), students predicted and explained information or events based on observation or previous experience. In 2nd grade (2-1.4), students inferred explanations regarding scientific observations and experiences. In 4th grade (4-1.6), students will construct and interpret diagrams, tables, and graphs made from recorded measurements and observations. In 7th grade (7-1.6), students will critique a conclusion drawn from a scientific investigation. In 8th grade (8-1.3), students will construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation.

It is essential for students to *infer*, or draw conclusions, from data communicated in tables, graphs, and diagrams.

- Data collected in an investigation can be represented on a graph, table, or diagram.
 - A table shows collected data in chart form. Tables are made of columns and rows. Categories are listed in the first (left) column and data collected are listed in columns to the right of the category column.
 - A graph (bar, pictograph) shows compared data.
 - A diagram is a graphic representation of an observation, relationship, comparison, or conclusion.
- Inferences can be made about the information in these graphs, tables, or diagrams.
- An *inference* is an explanation made without having actually observed the object or event.
- Inferences are based on data, previous experience, or prior knowledge.
- Patterns observed from the information presented in the graph, table, or diagram can be used to help make the inference.
- More than one inference can be made from the same graph, table, or diagram.

It is not essential for students to interpret other types of graphs.

Assessment Guidelines:

The objective of this indicator is to *infer* meaning from data communicated in graphs, tables, and diagrams; therefore, the primary focus of assessment should be to give explanations about data presented on a graph, table, or diagram. However, appropriate assessments should also require students to *predict* using collected data; *identify* patterns observed in graphs, tables, or diagrams; or *interpret* data communicated in graphs, tables, or diagrams.

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3-1 The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

3-1.7 Explain why similar investigations might produce different results.

Taxonomy Level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-1.3), students carried out simple scientific investigations when given clear directions. In 7th grade (7-1.4), students will explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation. In 8th grade, students will recognize the importance of a systematic process for safely and accurately conducting investigations (8-1.2) and explain the importance of and requirements for replication of scientific investigations (8-1.5).

It is essential for students to explain why results might be different even though the same investigation testing the same factors was being done by several groups. Reasons why an investigation could produce different results may be:

- The setup of the materials was not followed properly or in the exact same way.
- Similar procedures were not followed in the exact same way.
- Appropriate tools were not chosen to complete the experiment.
- Tools were not used properly.
- Measurements were not taken accurately.
- Different observations were collected.
- Mistakes were made when recording data, such as numbers written incorrectly.

Assessment Guidelines:

The objective of this indicator is to *explain* why similar investigations might produce different results; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the various ways that results are affected by different situations. However, appropriate assessments should also require students to *recall* how to carry out a scientific investigation; *infer* reasons why investigations may have different results; *compare* two or more investigations to observe how they differ; or *exemplify* ways the results of a scientific investigation can be affected.

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3-1 The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

3-1.8 Use appropriate safety procedures when conducting investigations

Taxonomy Level: 3.2-C Apply Procedural Knowledge

Previous/Future knowledge: In all grades students use appropriate safety procedures when conducting investigations that are appropriate to their grade, tools, and types of investigations.

It is essential for students to know that care should be taken when conducting a science investigation to make sure that everyone stays safe.

Safety procedures to use when conducting simple science investigations may be

- Always wear appropriate safety equipment such as goggles or an apron when conducting an investigation.
- Be careful with sharp objects and glass. Only the teacher should clean up broken glass.
- Do not put anything in the mouth unless instructed by the teacher.
- Follow all directions for completing the science investigation.
- Follow proper handling of animals and plants in the classroom.
- Keep the workplace neat. Clean up when the investigation is completed.
- Practice all of the safety procedures associated with the activities or investigations conducted.
- Tell the teacher about accidents or spills right away.
- Use caution when working with heat sources and heated objects.
- Wash hands after each activity.

It is essential for students to use tools safely and accurately, including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes when conducting investigations.

NOTE TO TEACHER (safety while working with students):

- Teacher materials have lists of “Safety Procedures” appropriate for the suggested activities. Students should be able to describe and practice all of the safety procedures associated with the activities they conduct.
- Most simple investigations will not have any risks, as long as proper safety procedures are followed. Proper planning will help identify any potential risks and therefore eliminate any chance for student injury or harm.
- Teachers should review with students the safety procedures before doing an activity.
- Lab safety rules may be posted in the classroom and/or laboratory where students can view them. Students should be expected to follow these rules.
- A lab safety contract is recommended to notify parents/guardians that classroom science investigations will be hands-on and proper safety procedures will be expected. These contracts should be signed by the student and the parents or guardians and kept on file to protect the student, teacher, school, and school district.
- In the event of a laboratory safety violation or accident, documentation in the form of a written report should be generated. The report should be dated, kept on file, include a signed witness statement (if possible) and be submitted to an administrator.
- Materials Safety Data Sheets (MSDS) must be on file for hazardous chemicals.
- For further training in safety guidelines, you can obtain the SC Lab Safety CD or see the Lab Safety flip-chart (CD with training or flip-chart available from the SC Department of Education).

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It is not essential for students to go beyond safety procedures appropriate to the kinds of investigations that are conducted in a third grade classroom.

Assessment Guidelines:

The objective of this indicator is to *use* appropriate safety procedures when conducting investigations; therefore, the primary focus of assessment should be to apply correct procedures that would be needed to conduct a science investigation. However, appropriate assessments should also require students to *identify* safety procedures that are needed while conducting an investigation; or *recognize* when safety procedures are being used.